

I CLAIM:

1. A gas flow regulation module for use with a pressure vessel, the pressure vessel having a wall adapted to contain a gas under a storage pressure in an interior space defined by the wall and an opening in the wall, the opening having a minimum opening diameter, the gas flow regulation module having:
  - a head portion having an exterior side and an opposed interior side;
  - a neck portion extending from the interior side of the head portion to an inner end thereof, the neck portion being adapted to be sealably secured in the opening;
  - a body portion extending from the inner end of the neck portion such that, when the neck portion is secured in the opening, the body portion is positioned in the interior space;
  - the body portion having a maximum external diameter which is less than the minimum opening diameter, to permit the insertion of the body portion through the opening into the interior space;
  - the body portion having:
    - a base;
    - an inlet port in fluid communication with the interior space of the pressure vessel when the body portion is positioned in the interior space;
    - a flow passage extending from the inlet port to a first stage regulator;
    - a transfer passage in the base extending from the first stage regulator to a second stage regulator;
    - the flow passage including a valve seat positioned therein, between the first stage regulator and the inlet port;
    - the valve seat defining an orifice;
  - an outlet passage extending from the second stage regulator to an outlet port located in the head portion;
  - the first stage regulator and the second stage regulator being adapted to reduce pressure exerted by the gas flowing therethrough from the storage pressure to an exit pressure;

a bore extending from a manual shut-off valve port in the head portion and through the neck portion and the base to the flow passage, the bore being in fluid communication with the flow passage; and

a manual shut-off valve including:

- a manual shut-off valve body sealably secured in the manual shut-off valve port;

- a valve stem extending in the bore from a proximal end thereof operatively connected to the manual shut-off valve body to a distal end;

- the distal end including an engagement portion with a sealing surface thereon, the sealing surface being adapted for sealable engagement with the valve seat to prevent gas flow through the orifice;

- the valve stem being movable between a closed position, in which the engagement portion engages the valve seat to seal the orifice and thereby prevent gas flow through the flow passage to the first stage regulator, and an open position, in which the engagement portion is disengaged from the valve seat such that the orifice is unobstructed, to permit gas to flow through the flow passage to the first stage regulator,

whereby the flow of gas through the gas regulation module is controllable by the manual shut-off valve.

2. A gas flow regulation module according to claim 1 in which the manual shut-off valve includes an actuator extending from the manual shut-off valve body and operably connected to the valve stem, for effecting movement of the valve stem between the open and closed positions.
3. A gas flow regulation module according to claim 1 in which the flow passage comprises a first segment extending from the inlet port to the orifice and a second segment extending from the orifice to the first stage regulator and the gas flow regulation module additionally includes:
  - a fill port located in the head portion;

a fill passage extending from the fill port to the bore, such that gas under a pressure exceeding the storage pressure is movable through the fill passage, to the bore and through the orifice to the first segment of the flow passage, and through the inlet port into the interior space.

4. A gas flow regulation module according to claim 1 in which the body portion additionally includes a solenoid valve assembly for controlling the flow of gas through the inlet port, the solenoid valve assembly including:
  - a valve body adapted for attachment to the base, the valve body including the inlet port and a valve body segment of the flow passage extending from the inlet port to the valve seat;
  - a solenoid valve seat located in the valve body segment defining an orifice; and
  - a solenoid valve mounted to an inner end of the valve body, the solenoid valve including:
    - a seal for engaging with the solenoid valve seat to sealably close the orifice;
    - a biasing means to bias the seal towards the solenoid valve seat to close the orifice;
    - a secondary piston connected to the seal; and
    - a coil for causing movement of the secondary piston such that the seal disengages from the solenoid valve seat when the coil is actuated.
5. A gas flow regulation module according to claim 4 additionally including:
  - a fill passage extending from the fill port to the bore adapted to permit gas under a fill pressure exceeding the storage pressure to pass through the bore to the orifice; and
  - the solenoid valve being adapted to open upon gas at the fill pressure entering into the valve body segment of the flow passage pushing the seal open, thereby forcing the seal to disengage from the solenoid valve seat, such that gas under the fill pressure passes through the first segment and the inlet port and into the interior space.

6. A gas flow regulation module according to claim 5 additionally including a filter assembly positioned in the fill passage to filter incoming gas.
7. A gas flow regulation module according to claim 1 additionally including a pressure relief valve in fluid communication with the outlet passage and positioned to vent via a relief outlet connection positioned in the head portion.
8. A gas flow regulation system including:
  - a pressure vessel, the pressure vessel having a wall adapted to contain a gas under a storage pressure in an interior space defined by the wall; the wall having an opening therein, the opening having a minimum opening diameter;
  - a gas flow regulation module for use with the pressure vessel, the gas flow regulation module having:
    - a head portion having an exterior side and an opposed interior side;
    - a neck portion extending from the interior side of the head portion to an inner end thereof, the neck portion being adapted to be sealably secured in the opening;
    - a body portion extending from the inner end of the neck portion such that, when the neck portion is secured in the opening, the body portion is positioned in the interior space;
    - the body portion having a maximum external diameter which is less than the minimum opening diameter, to permit the insertion of the body portion through the opening into the interior space;
    - the body portion having:
      - a base;
      - an inlet port in fluid communication with the interior space of the pressure vessel when the body portion is positioned in the interior space;
      - a flow passage extending from the inlet port to a first stage regulator ;

- a transfer passage in the base extending from the first stage regulator to a second stage regulator;
- the flow passage including a valve seat positioned therein, between the first stage regulator and the inlet port;
- the valve seat defining an orifice;
- an outlet passage extending from the second stage regulator to an outlet port located in the head portion;
- the first stage regulator and the second stage regulator being adapted to reduce pressure exerted by the gas flowing therethrough from the storage pressure to an exit pressure;
- a bore extending from a manual shut-off valve port in the head portion and through the neck portion and the base to the flow passage, the bore being in fluid communication with the flow passage; and
- a manual shut-off valve including:
  - a manual shut-off valve body sealably secured in the manual shut-off valve port;
  - a valve stem extending in the bore from a proximal end thereof operatively connected to the manual shut-off valve body to a distal end;
  - the distal end including an engagement portion with a sealing surface thereon, the sealing surface being adapted for sealable engagement with the valve seat to prevent gas flow through the orifice;
  - the valve stem being movable between a closed position, in which the engagement portion engages the valve seat to seal the orifice and thereby prevent gas flow through the flow passage to the first stage regulator, and an open position, in which the engagement portion is disengaged from the valve seat such that the orifice is unobstructed, to permit gas to flow through the flow passage to the first stage regulator,

whereby the flow of gas through the gas regulation module is controllable by the manual shut-off valve.

9. A gas flow regulation system according to claim 8 in which the manual shut-off valve includes an actuator extending from the manual shut-off valve body and operably connected to the valve stem, for effecting movement of the valve stem between the open and closed positions.
10. A gas flow regulation system according to claim 8 in which the flow passage comprises a first segment extending from the inlet port to the orifice and a second segment extending from the orifice to the first stage regulator and the gas flow regulation module additionally includes:
  - a fill port located in the head portion;
  - a fill passage extending from the fill port to the bore, such that gas under a pressure exceeding the storage pressure is movable through the fill passage, to the bore and through the orifice to the first segment of the flow passage , and through the inlet port into the interior space.
11. A gas flow regulation system according to claim 8 in which the body portion additionally includes a solenoid valve assembly for controlling the flow of gas through the inlet port, the solenoid valve assembly including:
  - a valve body adapted for attachment to the base, the valve body including the inlet port and a valve body segment of the flow passage extending from the inlet port to the valve seat; and
  - a solenoid valve seat located in the valve body segment defining an orifice; and
  - a solenoid valve mounted to an inner end of the valve body, the solenoid valve including:
    - a seal for engaging with the solenoid valve seat to sealably close the orifice;
    - a biasing means to bias the seal towards the solenoid valve seat to close the orifice;
    - a secondary piston connected to the seal; and

a coil for causing movement of the secondary piston such that the seal disengages from the solenoid valve seat when the coil is actuated.

12. A gas flow regulation system according to claim 11 additionally including:
  - a fill passage extending from the fill port to the bore adapted to permit gas under a fill pressure exceeding the storage pressure to pass through the bore to the orifice; and
  - the solenoid valve being adapted to open upon gas at the fill pressure entering into the valve body segment of the flow passage pushing the seal open, thereby forcing the seal to disengage from the solenoid valve seat, such that gas under the fill pressure passes through the first segment and the inlet port and into the interior space.
13. A gas flow regulation system according to claim 12 additionally including a filter assembly positioned in the fill passage to filter incoming gas.
14. A gas flow regulation system according to claim 8 additionally including a pressure relief valve in fluid communication with the outlet passage and positioned to vent via a relief outlet connection positioned in the head portion.